CLAIMS

What is claimed is:

1. An apparatus for determining constituent components of a flowing stream of an agricultural product as it is being processed on a real time basis, the apparatus comprising:

a light source, arranged to irradiate a sample portion of the flowing stream of agricultural product as it is being processed with a plurality of wavelengths within a selected irradiation bandwidth within a short wave near infrared spectrum;

an optical pick up, arranged to receive light energy diffusely reflected from the irradiated sample portion;

a wavelength separator, connected to receive light from the optical pick up, and to produce spatially separated light of different wavelengths; and

a detector, connected to receive light from the wavelength separator, and to produce detected intensity signals indicative of light intensity simultaneously at multiple selected wavelengths within the dispersing filter bandwidth.

2. An apparatus as in Claim 1 wherein the wavelength separator and detector are arranged such that the detected intensity signals at a given sample time represent the response of the apparatus for a range of wavelengths as taken from a sample portion of the flowing stream.

3. An apparatus as in Claim 1 wherein the wavelength separator is a linearly variable filter.

4. An apparatus as in Claim 1 wherein the flowing stream of agricultural product is in a combine.

5. An apparatus as in Claim 1 wherein the flowing stream of agricultural product is in a grain processor.

6. An apparatus as in Claim 1 wherein the flowing stream of agricultural product is in a storage facility.

7. An apparatus as in Claim 1 additionally comprising:
an optical fiber, disposed between the optical pick up and the wavelength separator, to couple light energy from an input end to an output end thereof.

8. An apparatus as in Claim 7 additionally comprising:
a mode mixer, disposed at the output end of the optical fiber, to attenuate variations in optical intensity of the light from the pick up introduced by the optical fiber.

9. An apparatus as in Claim 1 additionally comprising:
an analog to digital converter, connected to receive the detected intensity signals and to provide detected intensity values.

10. An apparatus as in Claim 9 additionally comprising:
a computer, connected to receive the detected intensity signals from the detector, and to calculate constituent components of the sample portion of the

agricultural product from the detected intensity values.

11. An apparatus as in Claim 10 wherein the computer repeats the calculation steps above and averages measurements of R and S to determine the absorption value.

12. An apparatus as in Claim 1 wherein the light source and optical pick up are placed in an optical head housing positioned adjacent a side opening in a product chute, and the wavelength separator and detector are placed remotely from the product chute, and wherein an optical fiber, is connected between the optical pick up and the wavelength separator to couple light energy between them.

13. An apparatus as in Claim 1 wherein the detector is a charge coupled device (CCD) array.

14. An apparatus as in Claim 1 wherein the constituent component is selected from the group consisting of protein, moisture, oil, starch, flour, and hardness.

15. In a harvester which includes a product chute for conveying a flowing stream of agricultural product, an analyzer for determining constituent components of the agricultural product as it is being harvested, the analyzer comprising:

a light source, arranged to irradiate a sample portion of the flowing stream of agricultural product as it is fed through the chute, the light source

providing a plurality of wavelengths within a selected optical irradiation bandwidth;

an optical pick up, for receiving light energy reflected from the irradiated sample portion;

a wavelength separator, receiving light from the optical pick up, and producing spatially separated light of different wavelengths;

a detector, receiving light from the wavelength separator, and producing detected intensity signals indicative of light intensity simultaneously at multiple selected wavelengths within the dispersing filter bandwidth; and

a computer, for receiving the detected intensity signals from the detector, and for calculating constituent components of the sample portion of the agricultural product from the detected intensity values.

16. A method for determining constituent components of a flowing stream of an agricultural product as it is being processed on a real time basis, the method comprising the steps of:

irradiating a sample portion of the flowing stream of agricultural product as it is being processed with a plurality of wavelengths within a selected irradiation bandwidth within a short wave near infrared spectrum;

picking up light energy diffusely reflected from the irradiated sample portion;

separating wavelengths of the picked up diffusely reflected light to produce spatially separated light of different wavelengths; and

detecting intensity signals from the separated wavelengths simultaneously at multiple selected wavelengths to simultaneously determine multiple light intensities.

17. A method as in Claim 16 wherein the steps of separating and detecting are performed such that the detected intensity signals at a given sample time represent the response for a range of wavelengths as taken from a single sample portion.

18. A method as in Claim 16 wherein the step of separating is performed by a linearly variable filter.

19. A method as in Claim 16 wherein the flowing stream of agricultural product is in a combine.

20. A method as in Claim 16 wherein the flowing stream of agricultural product is in a grain processor.

21. A method as in Claim 16 wherein the flowing stream of agricultural product is in a storage facility.

22. A method as in Claim 16 additionally comprising the steps of:

mode mixing the light energy provided by the picking up step, to attenuate variations in optical intensity of the light.

23. A method as in Claim 16 additionally comprising the step of:

converting the detected intensity signals to provide digital detected intensity values.

22 24. A method as in Claim 16 additionally comprising the step of:

calculating constituent components of the sample portion of the agricultural product from the detected intensity values.

23 25. A method as in Claim 22 24 additionally comprising the steps of:

selectively performing the step of picking up diffusely reflected light by operating a pick up shutter in a closed or open position;

selectively performing the step of separating wavelengths by operating an optics block shutter, in a closed or open position; and

wherein the step of calculating constituent components by determining an absorptivity by the steps of:

measuring a dark spectrum, D, as the response with the optics block shutter closed;

measuring a reference spectrum, R, by opening the optics block shutter and closing the pick up shutter;

measuring a sample spectrum, S, with both shutters open; and

determining a light absorption value, A, at the selected wavelength from the relationship

$A = LOG_{10} (R-D/S-D)$.

26. An method as in Claim 25 wherein the step of calculating is repeated to average measurements of R and S to determine the absorption value.

27. A short wave near infrared analysis system for obtaining percentage concentrations of constituents of a composite substance, comprising:

means for irradiating a composite substance simultaneously with short wave - near infrared radiation over a specified bandwidth;

means for simultaneously picking-up electromagnetic radiation reflected from said composite substance;

means for spatially separating wavelengths of electromagnetic radiation over the specified bandwidth as combined in the means for simultaneously picking-up radiation reflected;

means for individually detecting in parallel the wavelengths of the reflected electromagnetic radiation to obtain percentage concentration of the various constituents of said component substance; and

wherein the analysis system is attached to an agricultural combine for analyzing a flowing steam of agricultural produce on a real time basis during harvesting thereof.